

# DISPOSITION FORM

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# LEVEL

2

REFERENCE OR OFFICE SYMBOL

SUBJECT

DELNV-VI

NV&EOL G/AP Aerosol Atmospheric Models

TO Director, Visionics

FROM BSIT, VISD

DATE 7 Sep 78

CMT 1

1. In order to adequately model performance of E-0 sensors for use on the realistic battlefield, one element required is a model for the attenuation of visible, 1.06um and IR wavelength energy in fog, hazes, rain and snow. This model should relate to the measure of how far we are capable of seeing, namely the visibility. The model we have chosen has the form of a Beer's Law extinction, with an extinction coefficient which relates to transmission in the following manner:

$$T = e^{-\epsilon R}$$

T = Transmission

$\epsilon$  = Attenuation Coefficient

R = Range

12/16

The  $\epsilon$  8-12,  $\epsilon$  3-5 or  $\epsilon$  1.06 is normally plotted on log-log graph paper against  $\epsilon$  .55 which directly relates to the visibility.

2. The basic data for the NV&EOL G/AP Atmospheric Model has been collected during tests at Fort A. P. Hill, Virginia, Grafenwoehr and Baumholder, FRG. The data, as collected at AP Hill, has been broken into two groupings; labeled as wet and dry fog. A least square polynomial fit of order two was carried out on this atmospheric data. The fit was carried out in the log-log space relating the scattering attenuation coefficients of the 8-12um or (3-5um) region to that of the visible (.55um) region. The resulting curves are shown in Figures 1 and 2. Figure 1 shows the two curves one for each spectral region with the total data set of over 200 points making up the curve fit. These figures must be considered as preliminary as more data will be included in the curve fit as it becomes available. This fit will be corrected periodically.

3. The data utilized gives fits of the following form:

$$y = a + bx + cx^2$$

where y is log  $\epsilon$  3-5 or log  $\epsilon$  8-12 with x being log  $\epsilon$  .55

Although the data was not marked as wet or dry for Grafenwoehr or Baumholder, it appears through the data plots that it will group in this manner. The Baumholder data being dry and the Grafenwoehr data being wet. This has been plotted in this form and shown as Figures 3 and 4.

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4. The models and fit data for the 3-5 vs. visible curves are the following:

|          | A      | B     | C     | r <sup>2</sup> -linear<br>correlation | Root<br>Mean Error |
|----------|--------|-------|-------|---------------------------------------|--------------------|
| All Data | -1.000 | 2.404 | -.511 | .883                                  | .0147              |
| Dry Data | -1.667 | 3.398 | -.863 | .894                                  | .0115              |
| Wet Data | -.917  | 2.595 | -.782 | .824                                  | .0238              |

5. The models and fit data for the 8-12 vs. visible curves are the following:

|          | A      | B     | C     | r <sup>2</sup> -linear<br>correlation | Root<br>Mean Error |
|----------|--------|-------|-------|---------------------------------------|--------------------|
| All Data | -.980  | 1.851 | -.212 | .837                                  | .0207              |
| Dry Data | -1.712 | 2.565 | -.328 | .937                                  | .0158              |
| Wet Data | -1.144 | 2.871 | -.895 | .735                                  | .0338              |

Figure 2 shows the region of fit for these curves.

6. The data upon which these fits have been obtained are shown as Table I. The data is shown along with the date on which it was taken. This in turn can be related to the basic experimental data upon which the extinction coefficients have been based.

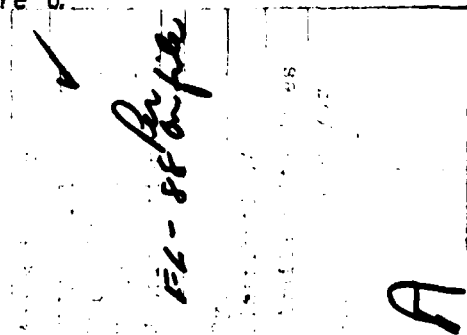
7. Figure 5 shows how the AP Hill data compares for 3-5 and 8-12 extinction coefficients plotted as functions of one another in two different ways. One case is a least square fit of these data directly and the other is a cross plot using the least square fits with the visible extinction as a parameter. It is shown that the cross plot is valid in the regions where the LSQF is also valid.

8. Data for the 1.06 micron extinction are found in Table II. These have been curve fit to the form outlined in Section 3 above. In this case

$$\begin{aligned} y & \text{ is } \log \frac{.55}{.8} \\ x & \text{ is } \log \frac{.8}{1.06} \end{aligned}$$

|           | A    | B    | C     | r <sup>2</sup> -linear<br>correlation | Root<br>Mean Error |
|-----------|------|------|-------|---------------------------------------|--------------------|
| 1.06 Data | .239 | .751 | -.281 | .891                                  | .0161              |

The curve corresponding to this fit is shown in Figure 6.



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9. The following expressions have been obtained as fits to rain and snow data.

Rain

$$\sigma_{8-12} = 10.0^{**}[1.04 * \log_{10}(+^{3.912}/R_{vis})+.037]$$

$$\sigma_{3-5} = 10.0^{**}[1.12 * \log_{10}(+^{3.912}/R_{vis})-.108]$$

Snow

$$\sigma_{8-12} = 10.0^{**} [.993 * \log_{10}(+^{3.912}/R_{vis})+.114]$$

$$\sigma_{3-5} = 10.0^{**}[1.05 * \log_{10}(+^{3.912}/R_{vis})+.021]$$

In these expression  $R_{vis}$  is the visibility range in kilometers.

*Frank J. Shields*

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VISED, NV&EOL

**NV&E<sub>0</sub>L G/AP AEROSOL MODEL**  
**EXTINCTION COEFFICIENTS**  
**LEAST SQUARE 2ND ORDER FIT 222 3-5 DATA PTS, 242 8-12 DATA PTS**

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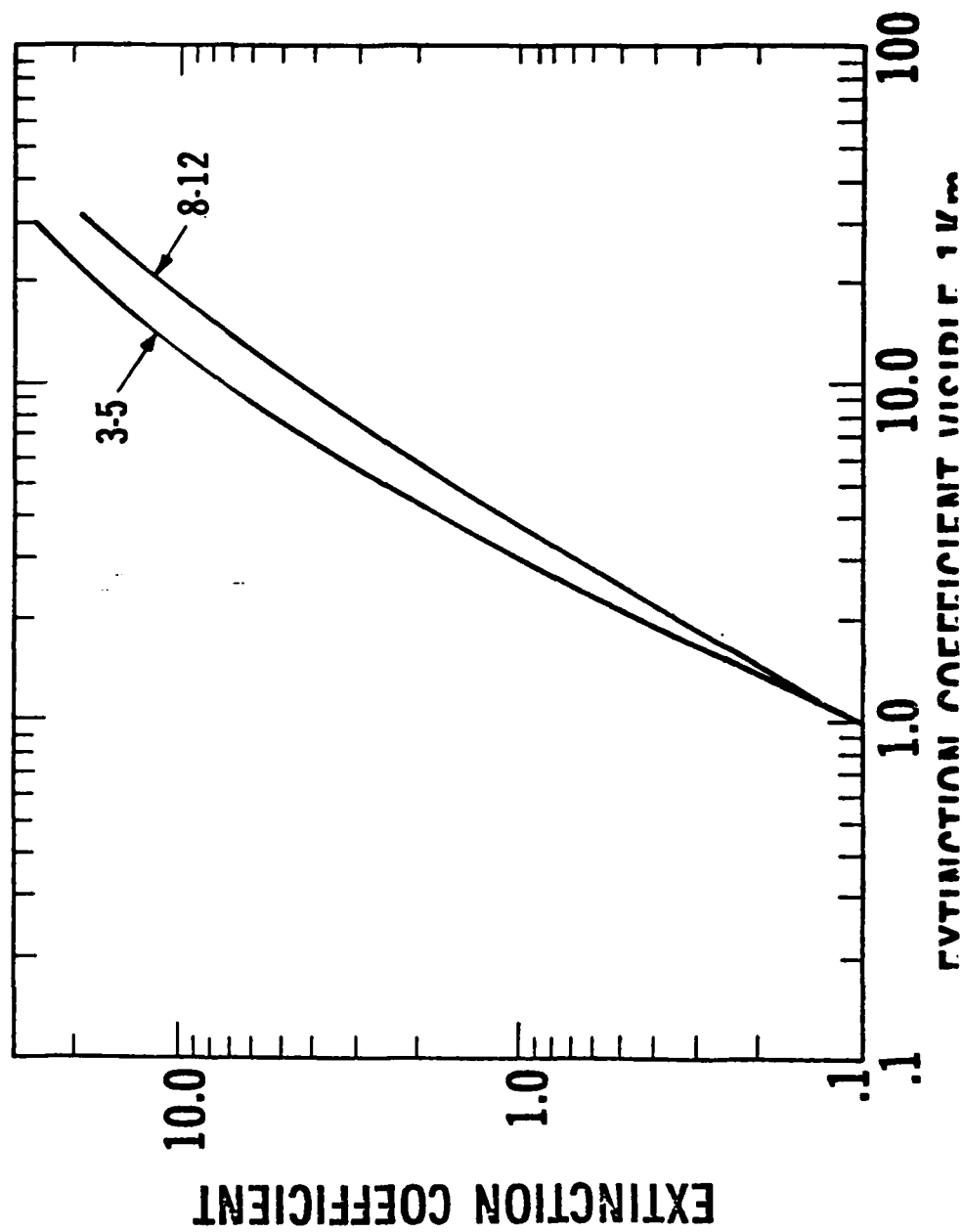


Fig. 1

# NV&EOL G/AP AEROSOL MODEL 8-12 $\mu$ m MODEL

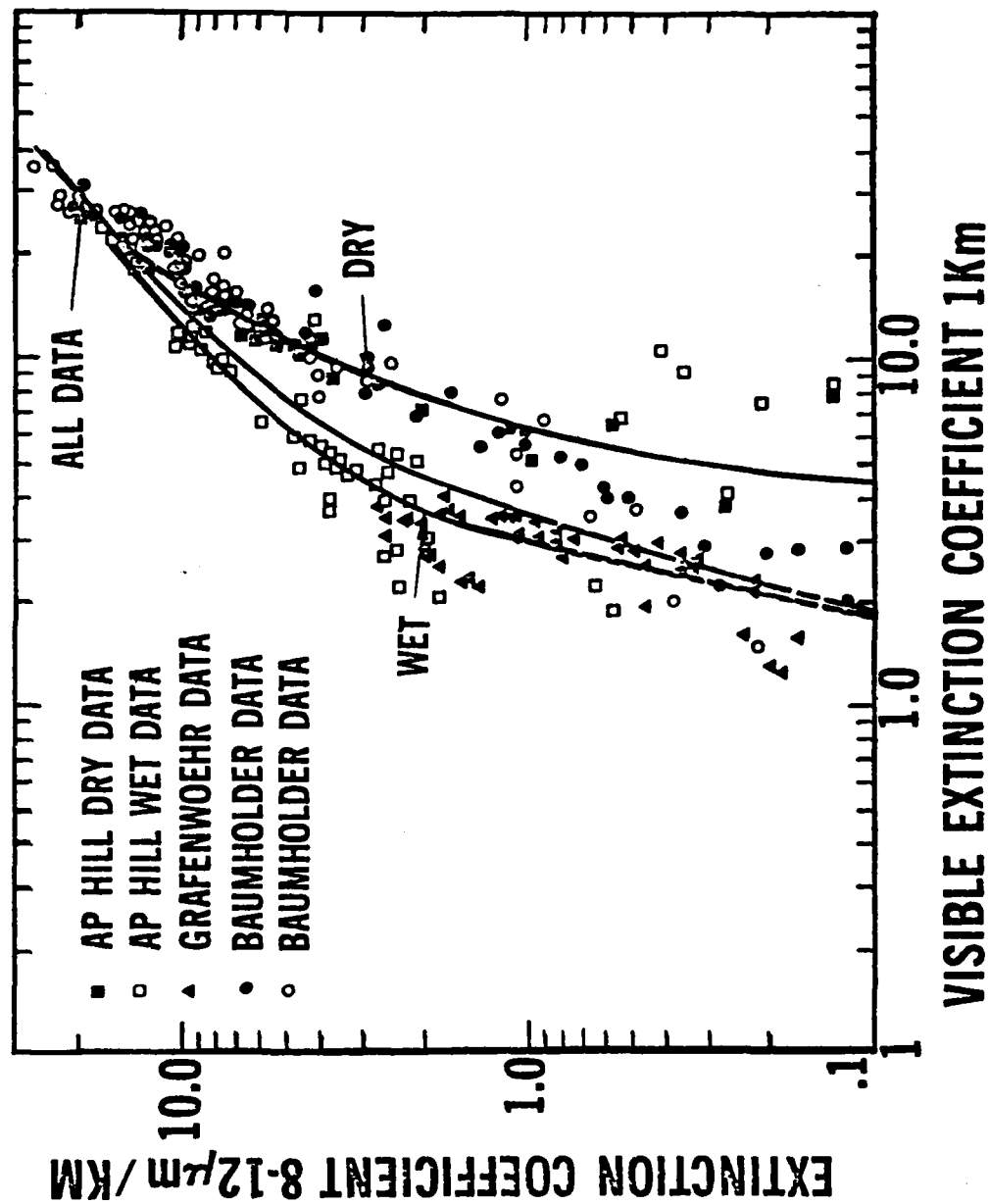
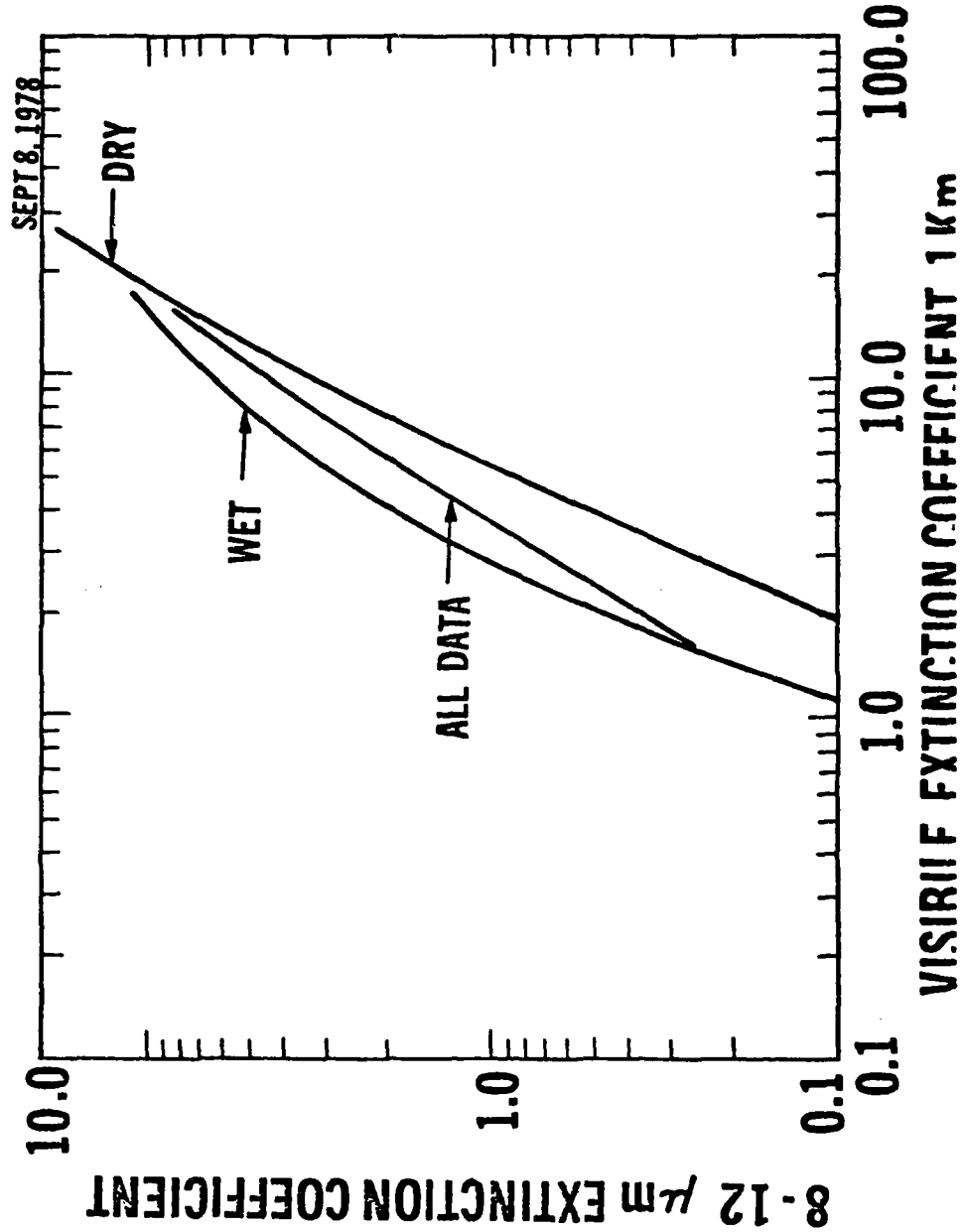


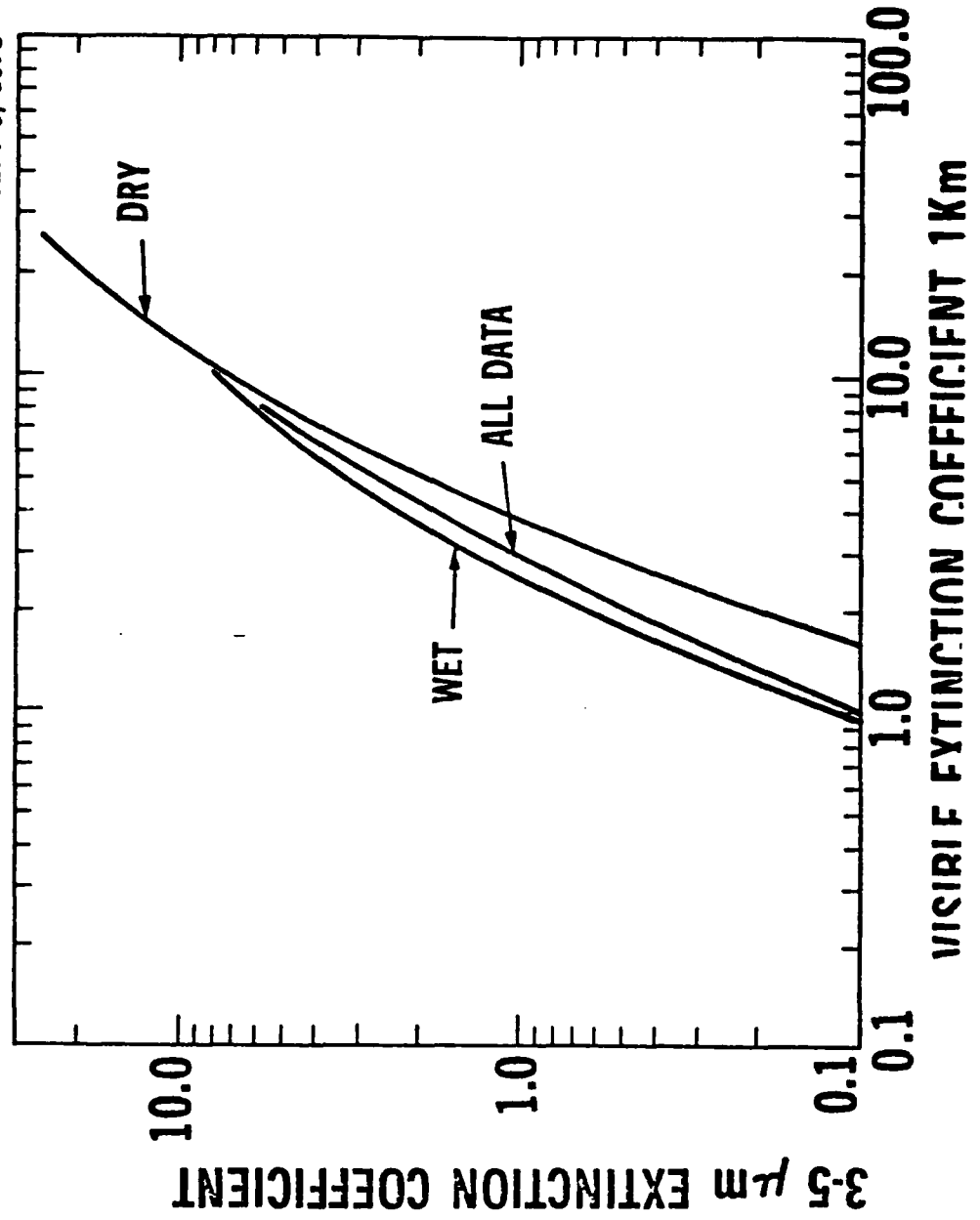
Fig. 2

# NV&EOL G/AP AEROSOL MODEL 8-12 $\mu\text{m}$ MODEL

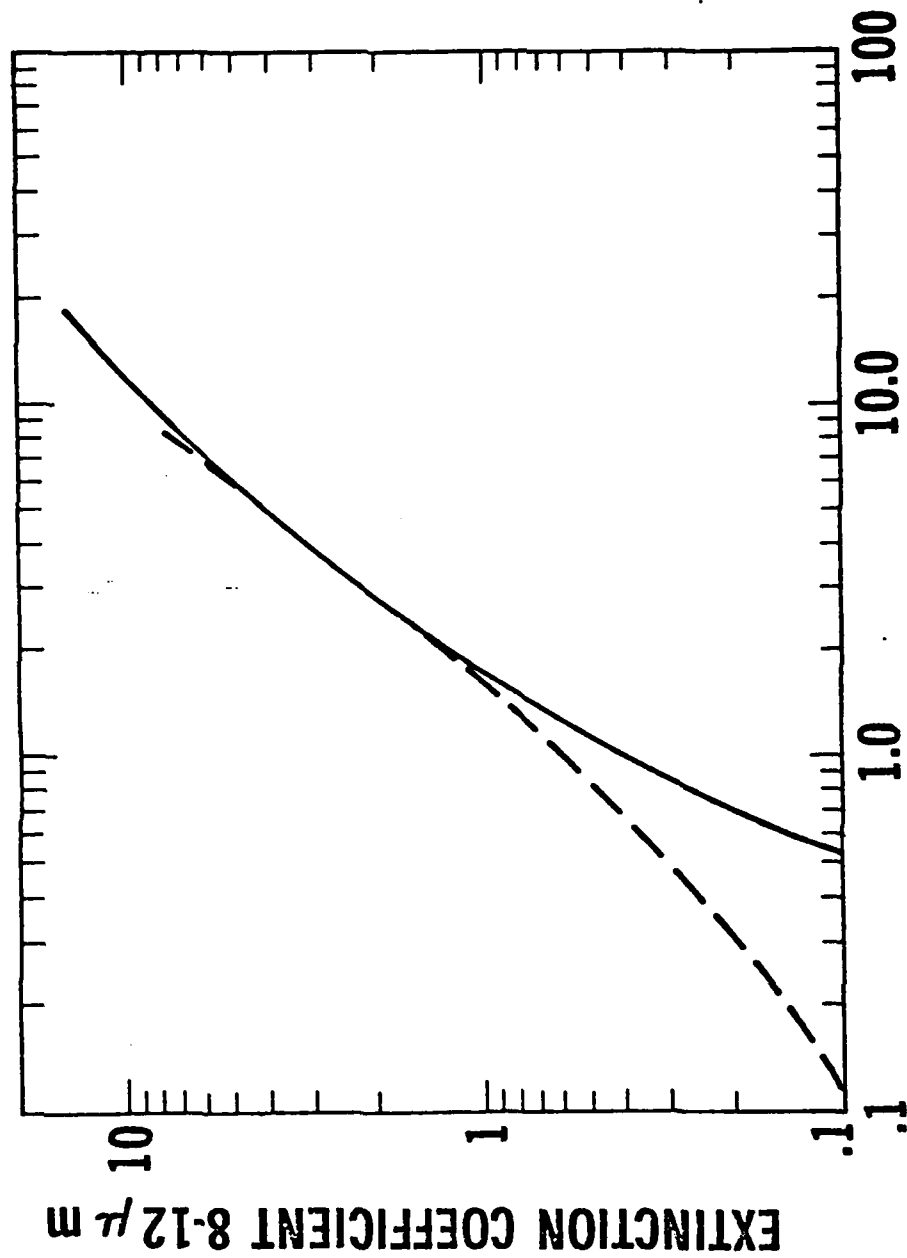


# NV&EOL G/AP AEROSOL MODEL 3-5 $\mu\text{m}$ MODEL

SEPT 8, 1978

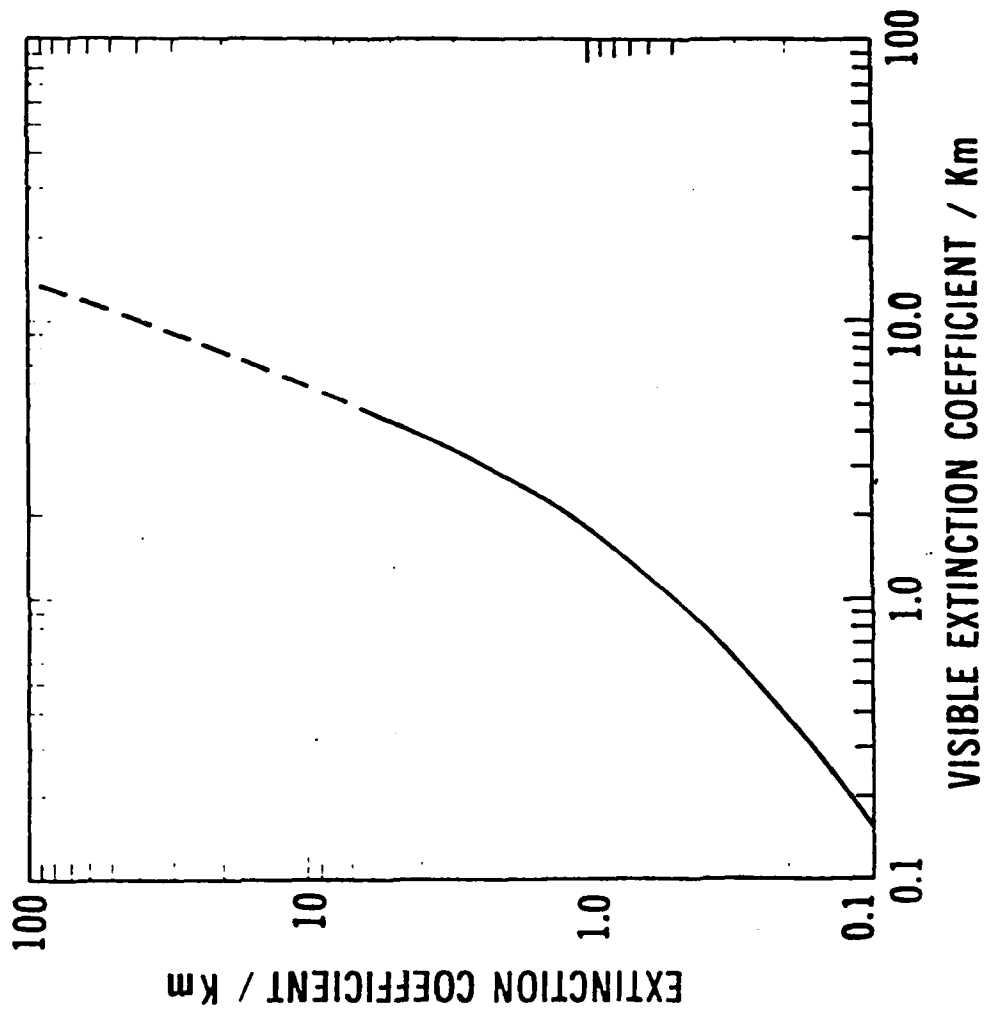


— LEAST SQUARE FIT 3.5  $\mu\text{m}$  vs 8-12  $\mu\text{m}$  DATA  
- - - CROSS PLOT USING VISIBILITY AS MAPPING COORDINATE





NV&EOL G/AP AEROSOL MODEL  
1.06  $\mu\text{m}$  MODEL



77 EXEC

001 "315.HIFLO" PHASE "LNKEOT " CPU= 00.00.08 OH= 00.00.02 AB= 00.00.00 TOT

FORM 611

| EXTINCT .55 UM | EXTINCT 3-5 UM | EXTINCT 3-12UM. | DATE | FOG TYP |
|----------------|----------------|-----------------|------|---------|
| 25.679993      | 0.0            | 13.200000       | 228  | w       |
| 21.199997      | 0.0            | 10.099999       | 228  | w       |
| 25.529999      | 0.0            | 21.709991       | 228  | w       |
| 32.187957      | 0.0            | 12.159988       | 228  | w       |
| 25.279990      | 17.309994      | 18.959991       | 228  | w       |
| 22.079987      | 24.309994      | 15.070000       | 228  | w       |
| 25.509995      | 26.609985      | 15.070000       | 228  | w       |
| 21.759995      | 21.929993      | 12.700000       | 228  | w       |
| 22.079987      | 22.619995      | 10.660000       | 228  | w       |
| 21.099991      | 22.369995      | 12.790000       | 228  | w       |
| 20.299988      | 19.649994      | 10.980000       | 228  | w       |
| 16.609983      | 16.539999      | 9.330000        | 228  | w       |
| 16.959991      | 17.009995      | 9.970000        | 228  | w       |
| 15.270000      | 14.520000      | 8.129999        | 228  | w       |
| 12.690000      | 11.719999      | 5.940000        | 228  | w       |
| 10.450000      | 9.560000       | 4.639999        | 228  | w       |
| 14.020000      | 12.780000      | 5.709999        | 228  | w       |
| 12.589995      | 19.959991      | 10.360000       | 228  | w       |
| 18.209991      | 17.709991      | 10.090000       | 228  | w       |
| 20.649994      | 19.979996      | 11.080000       | 228  | w       |
| 21.199997      | 18.599991      | 13.400000       | 228  | w       |
| 11.910000      | 11.929999      | 5.790000        | 228  | w       |
| 8.000000       | 7.429999       | 3.080000        | 228  | w       |
| 6.480000       | 6.349999       | 1.169999        | 228  | w       |
| 6.139999       | 4.450000       | 1.049999        | 228  | w       |
| 8.049999       | 5.980000       | 1.690000        | 228  | w       |
| 6.200000       | 5.009999       | 1.230000        | 228  | w       |
| 5.099999       | 3.739999       | 0.820000        | 228  | w       |
| 5.000000       | 2.929999       | 0.710000        | 228  | w       |
| 3.580000       | 1.040000       | 0.360000        | 228  | w       |
| 5.339999       | 4.690000       | 1.419999        | 228  | w       |
| 9.610000       | 9.009999       | 2.940000        | 228  | w       |
| 9.910000       | 10.320000      | 2.929999        | 228  | w       |
| 11.570000      | 13.059999      | 4.339999        | 228  | w       |
| 13.919999      | 16.919998      | 6.559999        | 228  | w       |
| 14.719999      | 16.399994      | 7.009999        | 228  | w       |
| 13.139999      | 12.389999      | 2.599999        | 228  | w       |
| 16.369999      | 17.019999      | 4.100000        | 228  | w       |
| 8.650000       | 7.440000       | 2.790000        | 228  | w       |
| 7.290000       | 5.349999       | 2.009999        | 228  | w       |
| 3.980000       | 1.770000       | 0.510000        | 228  | w       |
| 2.219999       | 0.310000       | 0.280000        | 228  | w       |
| 5.439999       | 4.049999       | 1.030000        | 228  | w       |
| 4.040000       | 1.580000       | 0.610000        | 228  | w       |
| 2.680000       | 0.400000       | 0.310000        | 228  | w       |
| 4.259999       | 1.799999       | 0.610000        | 228  | w       |
| 2.759999       | 0.310000       | 0.210000        | 228  | w       |
| 1.919999       | 0.130000       | 0.120000        | 228  | w       |
| 2.809999       | 0.300000       | 0.120000        | 228  | w       |
| 2.809999       | 0.490000       | 0.170000        | 228  | w       |
| 2.129999       | 0.220000       | 0.036000        | 228  | w       |
| 1.830000       | 0.220000       | 0.036000        | 228  | w       |
| 24.849991      | 24.000000      | 20.407798       | 301  | w       |
| 25.639987      | 0.0            | 22.249995       | 371  | w       |

|           |           |           |     |   |
|-----------|-----------|-----------|-----|---|
| 28.109935 | 0.0       | 24.149957 | 301 | W |
| 26.439957 | 0.0       | 21.119995 | 301 | W |
| 29.019951 | 0.0       | 17.759991 | 301 | W |
| 24.489940 | 0.0       | 25.959986 | 301 | W |
| 37.339946 | 0.0       | 27.429993 | 301 | W |
| 33.839940 | 0.0       | 24.439987 | 301 | W |
| 29.109938 | 0.0       | 20.750000 | 301 | W |
| 24.109935 | 0.0       | 17.319992 | 301 | W |
| 28.489990 | 0.0       | 13.299988 | 301 | W |
| 27.459991 | 0.0       | 14.879990 | 301 | W |
| 25.000000 | 0.0       | 16.379990 | 301 | W |
| 24.839940 | 23.609955 | 14.319999 | 301 | W |
| 22.109985 | 21.259995 | 13.290000 | 301 | W |
| 21.039993 | 21.159999 | 12.400000 | 301 | W |
| 24.199997 | 25.859995 | 14.150000 | 301 | W |
| 23.009995 | 25.799983 | 14.059999 | 301 | W |
| 25.849994 | 33.979996 | 15.310000 | 301 | W |
| 23.359985 | 25.369995 | 13.270000 | 301 | W |
| 23.469986 | 29.099991 | 12.540000 | 301 | W |
| 21.919995 | 22.000000 | 11.540000 | 301 | W |
| 20.659998 | 20.349991 | 10.570000 | 301 | W |
| 14.019939 | 20.199997 | 10.450999 | 301 | W |
| 17.519989 | 16.389999 | 10.250000 | 301 | W |
| 17.709991 | 16.569992 | 10.360000 | 301 | W |
| 16.609985 | 14.570000 | 10.259999 | 301 | W |
| 14.740000 | 12.400000 | 9.679999  | 301 | W |
| 13.339999 | 10.379999 | 8.360000  | 301 | W |
| 15.160000 | 12.310000 | 9.290000  | 301 | W |
| 13.919999 | 11.209999 | 8.660000  | 301 | W |
| 15.009999 | 11.759999 | 8.490000  | 301 | W |
| 14.360000 | 11.559999 | 8.790000  | 301 | W |
| 16.599991 | 15.540000 | 7.370000  | 301 | W |
| 17.069992 | 15.070000 | 7.900000  | 301 | W |
| 15.809999 | 13.509999 | 7.179999  | 301 | W |
| 20.089995 | 18.799988 | 7.799999  | 301 | W |
| 19.430000 | 13.919999 | 7.099999  | 301 | W |
| 14.740000 | 14.419999 | 7.520000  | 301 | W |
| 13.520000 | 12.099999 | 7.259999  | 301 | W |
| 13.469999 | 15.070000 | 7.339999  | 301 | W |
| 12.919999 | 9.570000  | 6.339999  | 301 | W |
| 12.780000 | 12.610000 | 6.679999  | 301 | W |
| 12.110000 | 5.430000  | 5.529999  | 301 | W |
| 11.469999 | 9.030000  | 5.730000  | 301 | W |
| 12.490000 | 10.150000 | 5.629999  | 301 | W |
| 11.040999 | 7.770000  | 5.059999  | 301 | W |
| 10.129999 | 5.959999  | 4.589999  | 301 | W |
| 10.669999 | 7.190000  | 4.320000  | 301 | W |
| 9.530000  | 5.959999  | 3.560000  | 301 | W |
| 7.110000  | 5.530000  | 4.120000  | 301 | W |
| 7.049999  | 5.129999  | 4.219999  | 301 | W |
| 10.569999 | 6.620000  | 3.290000  | 301 | W |
| 8.250000  | 5.410000  | 2.990000  | 301 | W |
| 7.820000  | 4.270000  | 2.509999  | 301 | W |
| 7.740000  | 3.200000  | 1.200000  | 301 | W |
| 5.759999  | 3.240000  | 0.900000  | 301 | W |
| 5.240000  | 2.190000  | 1.110000  | 301 | W |
| 4.350000  | 1.820000  | 1.110000  | 301 | W |
| 3.500000  | 1.120000  | 0.637000  | 301 | W |
| 3.730000  | 0.734000  | 0.431000  | 301 | W |
| 2.020000  | 0.330000  | 0.343000  | 301 | W |

|           |          |          |      |   |
|-----------|----------|----------|------|---|
| 1.520000  | 0.400000 | 0.021000 | 301  | W |
| 1.500000  | 0.500000 | 0.549000 | 3112 | W |
| 2.900000  | 0.500000 | 0.421000 | 3112 | W |
| 2.750000  | 0.500000 | 0.357000 | 3112 | W |
| 2.750000  | 0.500000 | 0.400000 | 3112 | W |
| 2.700000  | 0.500000 | 0.323000 | 3112 | W |
| 2.700000  | 0.500000 | 0.452000 | 3112 | W |
| 2.500000  | 0.500000 | 0.335000 | 3112 | W |
| 2.400000  | 0.350000 | 0.164000 | 3112 | W |
| 2.799999  | 0.739999 | 0.547000 | 3112 | W |
| 3.500000  | 1.421000 | 1.169000 | 3112 | W |
| 3.299999  | 1.237000 | 0.973000 | 3112 | W |
| 3.500000  | 1.355000 | 1.198999 | 3112 | W |
| 3.200000  | 1.014999 | 0.834000 | 3112 | W |
| 3.000000  | 0.855000 | 0.716000 | 3112 | W |
| 3.099999  | 1.054999 | 0.924000 | 3112 | W |
| 3.200000  | 1.176000 | 1.047000 | 3112 | W |
| 3.000000  | 1.299999 | 0.944000 | 3112 | W |
| 3.299999  | 1.024000 | 1.108000 | 3112 | W |
| 3.599999  | 2.217999 | 1.034999 | 3112 | W |
| 3.700000  | 1.900000 | 1.716000 | 3112 | W |
| 3.599999  | 2.058000 | 2.728999 | 3112 | W |
| 3.500000  | 1.841999 | 2.558999 | 3112 | W |
| 3.500000  | 2.132000 | 2.292000 | 3112 | W |
| 3.500000  | 1.988999 | 2.202999 | 3112 | W |
| 3.500000  | 1.400999 | 1.266999 | 3112 | W |
| 3.400000  | 1.405999 | 1.292999 | 3112 | W |
| 3.700000  | 2.014000 | 1.503000 | 3112 | W |
| 2.750000  | 2.235000 | 2.021000 | 3112 | W |
| 2.200000  | 1.710999 | 1.433999 | 3112 | W |
| 2.299999  | 1.841000 | 1.559999 | 3112 | W |
| 2.700000  | 2.285000 | 1.933999 | 3112 | W |
| 2.750000  | 2.564000 | 2.011000 | 3112 | W |
| 2.500000  | 2.313000 | 1.790000 | 3112 | W |
| 2.299999  | 2.120999 | 1.514000 | 3112 | W |
| 3.099999  | 3.220000 | 2.591999 | 3112 | W |
| 2.799999  | 1.820999 | 2.101000 | 3112 | W |
| 2.750000  | 2.117999 | 2.004999 | 3112 | W |
| 2.700000  | 1.707999 | 1.927999 | 3112 | W |
| 1.750999  | 0.193000 | 0.039000 | 3012 | W |
| 2.150000  | 0.310000 | 0.222000 | 3012 | W |
| 1.500000  | 0.269000 | 0.063000 | 3012 | W |
| 2.299999  | 0.382000 | 0.222000 | 3012 | W |
| 2.099999  | 0.296000 | 0.076000 | 3012 | W |
| 2.500000  | 0.627000 | 0.349000 | 3012 | W |
| 1.250000  | 0.0      | 0.184000 | 2912 | W |
| 1.209999  | 0.0      | 0.195000 | 2912 | W |
| 1.599999  | 0.0      | 0.235000 | 2912 | W |
| 1.950000  | 0.0      | 0.458000 | 2912 | W |
| 2.700000  | 0.0      | 0.403000 | 2912 | W |
| 4.000000  | 0.0      | 1.740000 | 2912 | W |
| 3.230000  | 0.420000 | 0.270000 | 1606 | D |
| 3.519999  | 4.099999 | 3.610000 | 1606 | D |
| 10.200000 | 6.770000 | 4.230000 | 1606 | D |
| 7.270000  | 3.570000 | 2.009999 | 1606 | D |
| 6.500000  | 2.740000 | 0.570000 | 1606 | D |
| 7.959999  | 0.910000 | 0.130000 | 1606 | D |
| 2.700000  | 0.180000 | 0.0      | 1606 | D |
| 3.150000  | 0.380000 | 0.070000 | 1606 | D |
| 10.729999 | 7.599999 | 4.370000 | 1606 | D |

|           |           |           |      |   |
|-----------|-----------|-----------|------|---|
| 15.109999 | 14.179999 | 3.740000  | 1606 | D |
| 13.200000 | 8.980000  | 5.839999  | 2810 | D |
| 15.209999 | 13.370000 | 3.339999  | 2810 | D |
| 11.320000 | 9.070000  | 4.379999  | 2810 | D |
| 5.059999  | 1.770000  | 0.930000  | 2810 | D |
| 11.650000 | 5.469999  | 3.900000  | 2810 | D |
| 11.370000 | 8.980000  | 5.379999  | 2311 | D |
| 11.679999 | 9.330000  | 6.190000  | 2810 | D |
| 12.410000 | 10.549999 | 6.570000  | 2311 | D |
| 18.069999 | 17.379999 | 13.200000 | 2311 | D |
| 13.590000 | 14.709999 | 9.009999  | 2311 | D |
| 13.110000 | 13.230000 | 7.730000  | 2311 | D |
| 13.590000 | 12.559999 | 8.809999  | 2311 | D |
| 12.020000 | 10.169999 | 6.230000  | 2311 | D |
| 11.520000 | 10.760000 | 5.770000  | 2311 | D |
| 2.109999  | 2.700000  | 2.379999  | 2710 | W |
| 2.059999  | 1.719999  | 1.799999  | 2710 | W |
| 4.309999  | 2.410000  | 2.379999  | 2710 | W |
| 5.079999  | 5.900000  | 5.990000  | 2710 | W |
| 5.990000  | 4.910000  | 4.349999  | 2710 | W |
| 2.730000  | 1.339999  | 2.440000  | 2710 | W |
| 6.759999  | 2.740000  | 0.570000  | 3005 | W |
| 5.240000  | 0.0       | 2.690000  | 211  | W |
| 4.620000  | 0.0       | 2.570000  | 211  | W |
| 5.280000  | 0.0       | 2.429999  | 211  | W |
| 4.959999  | 0.0       | 2.110000  | 211  | W |
| 2.259999  | 0.0       | 0.420000  | 211  | W |
| 1.549999  | 0.340000  | 0.0       | 211  | W |
| 1.419999  | 0.340000  | 0.0       | 211  | W |
| 7.799999  | 4.599999  | 4.500000  | 305  | W |
| 3.900000  | 2.200000  | 2.200000  | 305  | W |
| 1.759999  | 0.800000  | 0.590000  | 305  | W |
| 4.139999  | 0.420000  | 0.270000  | 305  | W |
| 3.049999  | 4.099999  | 3.610000  | 305  | W |
| 10.900000 | 6.770000  | 4.230000  | 305  | W |
| 7.679999  | 3.570000  | 2.009999  | 305  | W |
| 8.520000  | 0.910000  | 0.130000  | 305  | W |
| 11.709999 | 7.599999  | 4.370000  | 305  | W |
| 13.700000 | 14.179999 | 8.040000  | 305  | W |
| 10.920000 | 8.490000  | 7.340000  | 404  | W |
| 11.270000 | 9.969999  | 9.790000  | 404  | W |
| 12.030000 | 9.969999  | 9.500000  | 404  | W |
| 12.170000 | 10.719999 | 10.080000 | 404  | W |
| 12.470000 | 10.259999 | 8.440000  | 404  | W |
| 10.549999 | 10.690000 | 10.790000 | 404  | W |
| 11.379999 | 11.200000 | 10.860000 | 404  | W |
| 10.679999 | 9.830000  | 9.000000  | 404  | W |
| 0.240000  | 8.429999  | 7.959999  | 404  | W |
| 4.349999  | 9.570000  | 8.129999  | 404  | W |
| 9.039999  | 8.379999  | 7.700000  | 404  | W |
| 0.099999  | 9.160000  | 8.020000  | 404  | W |
| 0.360000  | 5.120000  | 4.490000  | 404  | W |
| 5.070000  | 4.669999  | 4.400000  | 404  | W |
| 5.559999  | 4.469999  | 4.399999  | 404  | W |
| 5.000000  | 4.059999  | 3.819999  | 404  | W |
| 4.720000  | 3.629999  | 3.270000  | 404  | W |
| 3.750000  | 2.360000  | 2.740000  | 404  | W |
| 5.000000  | 4.000000  | 3.730000  | 404  | W |
| 5.000000  | 3.879999  | 3.639999  | 404  | W |
| 5.000000  | 4.120000  | 3.790000  | 404  | W |

|           |           |           |        |   |
|-----------|-----------|-----------|--------|---|
| 4.690000  | 3.770000  | 3.469999  | 404    | W |
| 2.579999  | 2.460000  | 2.570000  | 2505 ✓ | W |
| 3.910000  | 3.759999  | 3.959999  | 2505   | W |
| 4.090000  | 4.520000  | 4.330000  | 2505   | W |
| 3.220000  | 4.160000  | 3.960000  | 2505   | W |
| 3.300000  | 2.610000  | 2.059999  | 2505   | W |
| 22.699997 | 15.500000 | 17.099991 | 2605 ✓ | W |
| 19.099991 | 15.500000 | 14.099999 | 2605   | W |
| 19.099997 | 14.900000 | 13.599999 | 2605   | W |
| 20.000000 | 16.000000 | 14.599999 | 2605   | W |
| 21.799983 | 7.200000  | 10.199997 | 2605   | W |
| 15.000000 | 12.599999 | 0.0       | 2605   | W |
| 15.599999 | 11.500000 | 0.0       | 2605   | W |
| 15.900000 | 11.200000 | 0.0       | 2605   | W |
| 7.000000  | 12.000000 | 0.0       | 2605   | W |

N = 242

27=0.0

7=0.0

| VISIBLE EXTINCTION | I.C.G. EXTINCTION | DATE OF EXPERIMENT |
|--------------------|-------------------|--------------------|
| 0.200000           | 0.120000          | 0.0 2106           |
| 0.280000           | 0.150000          | 0.0 1706           |
| 0.310000           | 0.190000          | 0.0 1706           |
| 0.330000           | 0.190000          | 0.0 1706           |
| 0.370000           | 0.190000          | 0.0 1706           |
| 0.390000           | 0.260000          | 0.0 2406           |
| 0.520000           | 0.190000          | 0.0 2306           |
| 0.520000           | 0.230000          | 0.0 2206           |
| 0.690000           | 0.280000          | 0.0 2206           |
| 0.690000           | 0.220000          | 0.0 2206           |
| 0.400000           | 0.330000          | 0.0 2106           |
| 0.410000           | 0.390000          | 0.0 2206           |
| 0.710000           | 0.330000          | 0.0 1706           |
| 0.420000           | 0.330000          | 0.0 1706           |
| 0.950000           | 0.300000          | 0.0 1706           |
| 1.500000           | 0.375000          | 0.0 1706           |
| 0.570000           | 0.420000          | 0.0 1606           |
| 0.615000           | 0.490000          | 0.0 2406           |
| 0.770000           | 0.440000          | 0.0 2206           |
| 0.820000           | 0.470000          | 0.0 1606           |
| 0.850000           | 0.470000          | 0.0 2106           |
| 1.099999           | 0.460000          | 0.0 2106           |
| 0.780000           | 0.560000          | 0.0 1506           |
| 0.890000           | 0.560000          | 0.0 2106           |
| 0.980000           | 0.520000          | 0.0 2406           |
| 1.000000           | 0.560000          | 0.0 1506           |
| 1.200000           | 0.520000          | 0.0 2406           |
| 1.549999           | 0.550000          | 0.0 2506           |
| 1.299999           | 0.620000          | 0.0 2806           |
| 1.400000           | 0.620000          | 0.0 2806           |
| 1.099999           | 0.650000          | 0.0 1606           |
| 1.290000           | 0.720000          | 0.0 1506           |
| 1.400000           | 0.780000          | 0.0 2806           |
| 1.299999           | 0.830000          | 0.0 1606           |
| 1.749999           | 0.725000          | 0.0 2406           |
| 2.200000           | 0.800000          | 0.0 2406           |
| 2.500000           | 0.820000          | 0.0 2406           |
| 1.900000           | 1.090000          | 0.0 1606           |
| 2.000000           | 1.099999          | 0.0 2106           |
| 1.569999           | 1.299999          | 0.0 2106           |
| 1.089999           | 1.400000          | 0.0 1506           |
| 2.299999           | 1.400000          | 0.0 1606           |
| 2.900000           | 1.500000          | 0.0 2106           |
| 2.299999           | 1.599999          | 0.0 2106           |
| 2.500000           | 1.700000          | 0.0 1506           |
| 2.900000           | 1.700000          | 0.0 1506           |
| 3.440000           | 1.700000          | 0.0 1506           |
| 1.000000           | 1.299999          | 0.0 1606           |
| 1.200000           | 1.299999          | 0.0 1606           |
| 1.200000           | 1.400000          | 0.0 1606           |
| 2.400000           | 1.099999          | 0.0 1706           |
| 3.000000           | 2.099999          | 0.0 1606           |
| 1.799999           | 2.400000          | 0.0 1506           |
| 4.000000           | 2.599999          | 0.0 1506           |
| 7.400000           | 2.900000          | 0.0 2106           |
| 3.500000           | 2.599999          | 0.0 1506           |
| 4.070000           | 3.200000          | 0.0 1606           |
| 5.750000           | 3.299999          | 0.0 1506           |
| 5.799999           | 6.450000          | 0.0 1606           |
| 7.000000           | 7.000000          | 0.0 1606           |

TABLE II

|          |          |     |      |
|----------|----------|-----|------|
| 0.900000 | 1.200000 | 0.0 | 2706 |
| 1.200000 | 1.000000 | 0.0 | 2706 |
| 1.500000 | 1.000000 | 0.0 | 2706 |
| 1.800000 | 1.500000 | 0.0 | 2806 |
| 1.900000 | 1.500000 | 0.0 | 2806 |
| 2.500000 | 2.000000 | 0.0 | 2706 |
| 1.500000 | 0.850000 | 0.0 | 1806 |
| 1.500000 | 0.850000 | 0.0 | 2106 |
| 1.700000 | 0.940000 | 0.0 | 2406 |
| 5.000000 | 3.700000 | 0.0 | 2706 |
| 2.200000 | 0.740000 | 0.0 | 2106 |
| 1.500000 | 0.700000 | 0.0 | 2106 |
| 1.700000 | 0.700000 | 0.0 | 2106 |
| 2.700000 | 2.000000 | 0.0 | 2706 |
| 2.900000 | 1.950000 | 0.0 | 2706 |
| 2.799000 | 2.000000 | 0.0 | 2706 |
| 3.000000 | 2.200000 | 0.0 | 2706 |
| 3.400000 | 2.450000 | 0.0 | 2706 |
| 3.700000 | 2.540000 | 0.0 | 1306 |
| 3.900000 | 2.790000 | 0.0 | 1306 |
| 4.000000 | 3.000000 | 0.0 | 1306 |
| 5.000000 | 3.700000 | 0.0 | 1306 |
| 5.200000 | 4.000000 | 0.0 | 1306 |
| 7.200000 | 6.500000 | 0.0 | 1306 |

N = 85 POINTS.

## TABLE II

1.06 NM VS VISIBLE

EXTINCTION DATA